

DOCUMENT RESUME

ED 331 489

IR 014 990

AUTHOR Morse, Ronald H.
TITLE Computer Uses in Secondary Science Education. ERIC Digest.
INSTITUTION ERIC Clearinghouse on Information Resources, Syracuse, N.Y.
SPONS AGENCY Office of Educational Research and Improvement (ED), Washington, DC.
REPORT NO EDO-IR-91-1
PUB DATE Apr 91
CONTRACT RI88062008
NOTE 4p.
AVAILABLE FROM ERIC Clearinghouse on Information Resources, Syracuse University, 030 Huntington Hall, Syracuse, NY 13244-2340 (free with stamped, self-addressed envelope while supply lasts).
PUB TYPE Information Analyses - ERIC Clearinghouse Products (071)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Academic Achievement; Computer Literacy; *Computer Uses in Education; Databases; Educational Strategies; Interactive Video; Locus of Control; Microcomputers; *Science Education; Secondary Education; *Secondary School Curriculum; Word Processing
IDENTIFIERS ERIC Digests; Microcomputer Based Laboratories

ABSTRACT

The importance of using computers in a science education class is not limited to computer-assisted instruction (CAI). Computers may also be used as an educational strategy to improve overall learning and computer literacy in students. Research has shown an improvement in academic achievement in students using computers, as well as an increase in scientific reasoning skills and scientific knowledge. Many science teachers are currently using computers to produce tests and worksheets; record, calculate, and post student grades; develop tests and worksheets; and produce supplementary items such as crossword puzzles, posters, and diagrams to support instructional activities. A small number of teachers also use computers as a component in selected laboratory activities, and students are being increasingly introduced to computer database searching. On the cutting edge of classroom computer applications, interactive video disks (on biology, earth science, physics, and chemistry) are making their way into many science classrooms. The major factor inhibiting computer use is insufficient computer hardware and software due to budgetary constraints. Ideally, students would have access to individual microcomputer workstations complete with touch-screen interactive video and high quality computer managed instruction that would allow them to proceed at their own pace. In this situation, the role of the science teacher would be dramatically different, yet just as valuable and rewarding as it is now. Science education in the future will incorporate computer use--including word processing, many forms of computer assisted instruction (CAI), laboratory instrumentation, interactive video courseware, and scientific database searching--and the educational process will be better because of it. (8 references) (DB)

- ☐ This document has been reproduced as received from the person or organization originating it.
- ☐ Minor changes have been made to improve reproduction quality.

- Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

ED331489

Computer Uses in Secondary Science Education

ERIC Digest

by

Ronald H. Morse

ERIC Clearinghouse on Information Resources
Syracuse University
April 1991

IR014990

April 1991

EDO-IR-91-1

Computer Uses In Secondary Science Education

by Ronald H. Morse

Computer use by any teacher is a function of his or her computer experience and expertise, availability of hardware and software, and perceived need. An excellent science course may be taught without the use of a computer. However, the careful incorporation of computers into a science course can and does add an important level of enhancement. Although not as conclusive as one might hope, studies do indicate that computer use in science education can improve learning and positively influence students' attitudes and self-esteem.

The importance of using computers in a science class may not be limited to the ability of computer assisted instruction (CAI) to improve learning. Rather, computer use adds another dimension to the teacher's repertoire of strategies, which may improve overall learning. Another important reason to include student computer use in a science course is that most (if not all) students, especially those planning a career in science, will be required to be computer literate. As students interact with computers in a variety of ways within their science courses, their degree of computer awareness and literacy will increase.

What Research Finds

The following studies found positive effects associated with microcomputer use in science education applications:

- Higher achievement and more positive attitudes were observed in a high school biology course that was "computer-loaded" (Hounshell & Hill, 1989).
- Scientific reasoning skills were found to be enhanced using a microcomputer-based curriculum (Friedler, Nachmias, & Songer, 1989).
- Specialized computer programs were found to help develop inquiry skills while also increasing scientific knowledge even when strong "misconceptions" were present at the start (Shute & Bonar, 1986).

More than one study found that computer use by students enhanced their self-esteem (Robertson, Ladewig, Strickland, & Boschung, 1987). This may also account, in part or in whole, for the increased interest in science by lower achieving students who have computers incorporated into their curriculum. Whatever the reason, the effect is positive and adds another reason to use computers in the classroom.

Some studies, however, find CAI to be of limited value in science applications, especially when the control group is given equivalent non-computer support. For example, a study by Wainwright (1989) showed that a control group using worksheets scored significantly higher than did an experimental group using CAI. Wainwright suggests that paper and pencil worksheets allowed the students to more easily experiment with trial and error in balancing chemical equations.

A major problem in evaluating the results of studies designed to measure the value of CAI is the elusive factor of the quality of the software used in the study. Not only should the software be well designed, but there also must be a match between the objectives of the software (or courseware), the understanding of the teacher as to how to apply it, and the needs or interests of the students.

How Science Teachers Are Using Computers

Most teachers are willing to incorporate computers into their curricula when the obstacles are not overwhelming. The desired uses, however, include more than CAI. In fact, a relatively small number of science teachers use computers for CAI and lab applications because there isn't enough hardware and because lab applications require both specialized hardware and software. A study of secondary science teacher needs (Baird & Rowsey, 1989) revealed that, of the nearly 800 respondents, 70% wished to know more about using computers to deliver science instruction, 64% to manage instruction, and 60% to use a test item data bank.

The most widely used application appears to be word processing. Test and worksheet production takes the lead in this area, and customized laboratory activities are produced as well. Many science teachers employ spreadsheet or customized or commercial grade book programs to record, calculate, and post student grades. Using test item banks to sort and select questions is becoming more popular as software and banks become more available. Finally, a small number of teachers are using computers to produce items such as crossword puzzles, word searches, posters, signs, and diagrams to support instructional activities.

A small but increasing number of science teachers are using computers as a component in selected laboratory activities. Microcomputer-based laboratories (MBLs) employ computers interfaced with commercial or "home-built" transducers. Using the appropriate software allows the computers to measure, record, graph, and analyze a variety of physical quantities: temperature, light, pH, pressure, and electrical and magnetic parameters, to list the most common. Some teachers create their own programs, in a computer language such as BASIC, that allow both students and teachers to evaluate the accuracy of laboratory data and/or calculations.

On the cutting edge of classroom computer applications, interactive videodisks are making their way into many science classrooms. To date, the most popular subject areas have been biology and earth science, and interactive video programs with related courseware have recently been produced for physics and chemistry. A physical science curriculum project in Texas purports to have had significant success with a videodisk-based program. The report states that even though the effects of using this curriculum varied

considerably by teacher and other factors, the overall results were positive, with the greatest achievement gains being for "low-ability" students (Savenye & Strand, 1989).

Finally, students are increasingly being introduced to computer database searching at school. Many high schools subscribe to databases on CD-ROM (compact disk, read-only memory). In addition, modems are used to access university and government databases at remote locations. Such databases range from libraries' online catalogs to scientific data being gathered from spacecraft and satellites.

Constraints to Classroom Computer Use

By far the major factor inhibiting computer use in the classroom is the insufficient amount of computer hardware and software available due to budgetary constraints. It often takes a science department three to six years to obtain even the minimum number of computers necessary for one teacher to effectively incorporate CAI and MBLs into the curriculum. Although just one or two computers can be incorporated into classroom activities, this number will support a very limited number of strategies. Moving computers in and out of a classroom is time consuming and significantly inhibits their use. Moving students to a "computer lab" also has several constraints, the two major ones being that the typical computer lab is too small and that teachers must compete for limited lab time.

The Ideal Computer Environment

An ideal computer learning environment, possible with current technology, might be an arrangement where each student has access to a "friendly" computer station consisting of high quality computer managed instruction (CMI), touch screen color displays and interactive video. At such a station each student could proceed at his or her own rate. Motivated students of the very highest ability might learn at three to four times the average classroom rate, completing two or three high school science courses a year. Students who seem to learn more slowly could be given extra months to complete a course without failure. The "average" student might elect to proceed at a pace equivalent to the conventional course.

An important feature of the CMI would be the learner's ability to choose whether to proceed or to review when attempting to master course objectives. Research has shown that learning increases when the learner has some control over the CAI program (Kinzie, Sullivan, & Berdel, 1988). In addition, students would be encouraged to repeat for themselves demonstrations observed on the interactive videodisk. And, regardless of the degree of computer involvement, there must also be a substantial hands-on laboratory component integrated into each science course. MBLs would also play a major role in the labs of the future.

Students in the ideal computer environment would also be encouraged (or required) to participate in cooperative activities as part of the complete science course, perhaps in the form of problem solving activities that would not require that all students in a group be at the same level of instruction. Indeed, it might be very beneficial to create cooperative problem solving groups composed of students currently studying topics in different areas (i.e. earth science, biology, chemistry, and physics), or at differing levels of an integrated science curriculum.

The role of the teacher in a room of 24 such individual stations would be to discuss questions and concerns brought to them by the students, as well as coordinate and oversee laboratory activities. The role of the science teacher would be dramatically different, yet just as valuable and rewarding as it is now. The teacher's job might become even more

rewarding as ideal learning conditions replace the disadvantages of group instruction and more time becomes available for meaningful student contact (Robertson, Ladewig, Strickland, & Boschung, 1987).

Conclusion

Computer use in the classroom is still in its infancy. Its overall effectiveness needs to be enhanced by better hardware and software as well as greatly increased availability of each. More research is needed to discover the most effective strategies for their use. The rate at which computers will be used to enhance education, in science and in other fields, depends mainly upon state and national monetary commitment, followed by the willingness of individual schools to provide good inservice programs.

Science education of the future will certainly incorporate computer use—including word processing, many forms of CAI, laboratory instrumentation, interactive video courseware, and scientific database searching—and the educational process will be better because of it.

References

- Baird, W. E., & Rowsey, R. E. (1989, April). A survey of secondary science teachers' needs. *School Science and Mathematics*, 89(4), 272-84. EJ 392 783.
- Friedler, Y., Nachmias, R., & Songer, N. (1989, January). Teaching scientific reasoning skills: A case study of a microcomputer-based curriculum. *School Science and Mathematics*, 89(1), 272-84. EJ 389 530.
- Hounshell, P. B., & Hill, S. R. (1989, September). The microcomputer and achievement and attitudes in high school biology. *Journal of Research in Science Teaching*, 26(6), 543-49. EJ 401 364.
- Kinzie, M. B., Sullivan, H. J., & Berdel, R. R. (1988, September). Learner control and achievement in science computer-assisted instruction. *Journal of Educational Psychology*, 80(3), 299-303. EJ 388 059.
- Robertson, E. B., Ladewig, B. H., Strickland, M. P., & Boschung, M. D. (1987, May-June). Enhancement of self-esteem through the use of computer-assisted instruction. *Journal of Educational Research*, 80(5), 314-16. EJ 358 691.
- Savenye, W. C., & Strand, E. (1989, February). Teaching science using interactive videodisc: Results of the pilot year evaluation of the Texas Learning Technology Group Project. In *Proceedings of selected research papers presented at the Annual Meeting of the Association for Educational Communications and Technology* (Dallas, TX, February 1-5, 1989). 20pp. ED 308 838.
- Shute, V., & Bonar, J. (1986). *Intelligent tutoring systems for scientific inquiry skills*. Pittsburgh, PA: Pittsburgh University, Learning Research and Development Center. 19pp. ED 299 134.
- Wainwright, C. L. (1989, April). The effectiveness of a computer-assisted instruction package in high school chemistry. *Journal of Research in Science Teaching*, 26(4), 275-90. EJ 392 674.

This digest was prepared for the ERIC Clearinghouse on Information Resources by Ronald H. Morse, a chemistry teacher at East Syracuse-Minoa High School and continuing education instructor at Syracuse University. April 1991.

ERIC Digests are in the public domain and may be freely reproduced and disseminated.